Serial Number 09/931,237

AMENDMENTS TO CLAIMS

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

1. (Currently Amended) A system for rapidly tracking ~~tacking~~ multiple faces, comprising:

a face-like region generator having a skin region extractor, ~~and~~ a motion analyzer and a silhouette analyzer, the skin region extractor generating a plurality of skin regions by detecting skin color pixels of an input image, the motion analyzer determining possible face-like regions from the skin regions based on moving information of the input image, and the silhouette analyzer analyzing whether there exists a raised shape in the input image to accordingly separate connected face regions and determining that there exists a face-like region based on the following conditions: e(i)>w and e(j)<-w, where w=0.5*(p(j)-p(i)); e(i)=d(p(i)); d(x)=v(x-1)-v(x+1); v(x) denotes a vertical position of the first touched pixel of a connected region when tracking all pixels of an image along the x-th column from top to down; e( ) denotes the edge response of a vertical edge; p( ) denotes a position of the vertical edge; i denotes an ith pixel; j denotes a jth frame; and w denotes a weight of the face-like region;

a face recorder for recording tracked faces;

a face status checker for checking the face-like regions and the faces previously tracked and recorded in the face recorder to determine whether the face-like regions are old faces which have been tracked in a previous frame or ~~are~~ possible new faces that are newly occurring faces;

a face verification engine for determining whether the possible new faces are ~~true~~ new faces; and

a face tracking engine for tracking multiple faces based on the new and old faces, and the skin regions provided by the skin region extractor, wherein, when a tracked face is a new face, the face tracking engine directly adds the new face to the face recorder; and when a tracked face is an old face, the face tracking engine determines whether there exists more than a predefined

percentage of overlapping area between the old face and a skin region;[[,]] ~~and~~ wherein ~~if yes~~ there exists more than a predefined percentage of overlapping area between the old face and a skin region, ~~it is determined~~ the face tracking engine determines that the old face is still in the current frame and locates ~~its position is~~ in the center of the skin region; and if there does not exist more than a predefined percentage of overlapping area between the old face and a skin region, ~~otherwise,~~ the position of the old face is determined by a correlation operation.

2. (Original) The system as claimed in claim 1, wherein, if the face tracking engine determines that there exists more than a predefined percentage of overlapping area between an old face and a skin region, the face-like region is labeled as a tracked old face.

3.(Original) The system as claimed in claim 1, wherein, in the motion analyzer, luminance difference between two successive images is used as a moving information, and a pixel is defined as a moving pixel if its luminance difference between two adjacent images is larger than a threshold; if there are more than a predefined percentage of pixels classified as moving pixels in a skin region, the region is labeled as a possible face-like region.

4.(Original) The system as claimed in claim 3, wherein the skin region extractor generates a plurality of connected skin regions based on an adaptive skin color model representing skin features of different people.

5.(Currently Amended) The system as claimed in claim 4, further comprising an adjuster for dynamically updating the adaptive skin color model according to an update ~~in response to variation~~ of the face recorder.

6. (Canceled)

7. (Canceled)

8.(Currently Amended) The system as claimed in claim 1[[6]], wherein the face verification engine has a filter and an verification processor; said filter filters out false faces from input possible new faces, and the other possible new faces are fed into the verification processor for finding ~~true~~ new faces by eigen-face analysis.

9.(Currently Amended) The system as claimed in claim 8, wherein the filter finds a false face based on a combination of compactness of a tracked region, ratio between the height and width of a face, statistic variance of a face, number of holes existing ~~existed~~ in a region, and convexity of a face.

10.(Currently Amended) A system for rapidly ~~tacking~~ tracking multiple faces comprising:
a face-like region generator having a skin region extractor, a motion analyzer and a silhouette analyzer, the skin region extractor generating a plurality of skin regions by detecting skin color pixels of an input image; the motion analyzer determining possible face-like regions from the skin regions based on moving information of the input image, the silhouette analyzer analyzing whether there exists a raised ~~protrusion~~ shape in the image ~~so as~~ to accordingly separate connected regions, and the silhouette analyzer determining that there exists a face-like region based on the following conditions: e(i)>w and e(i)<-w, where w=0.5*(p(j)-p(i)); e(i)=d(p(j)); d(x)=v(x-1)-v(x+1); v(x) denotes a vertical position of the first touched pixel of a connected region when tracking all pixels of an image along the x-th column from top to down; e( ) denotes the edge response of a vertical edge; p( ) denotes a position of the vertical edge; i denotes an ith pixel; j denotes a jth frame; and w denotes a weight of the face-like region;

a face verification engine for determining that possible new faces are new faces which are newly occurring in a current frame; and

a face tracking engine for tracking multiple faces based on the old and possible new faces and the skin regions provided by the skin region extractor, wherein the face tracking engine has a filter and a verification processor; the filter filters out false faces from input possible new faces, and the other possible new faces are fed into the verification processor for finding the new faces by eigen-face analysis;

a face recorder for recording faces that have been tracked by the face tracking engine; and

a face status checker for checking the face-like regions and the faces previously tracked and recorded in the face recorder to determine whether the face-like regions are old faces which have been tracked in a previous frame or are possible new faces that are newly occurring faces, wherein only the possible new faces determined are fed into the face verification engine, and the old faces are directly fed into the face tracking engine.

Claim 11 (Canceled)

12.(Currently Amended) The system as claimed in claim 10[[11]], wherein, if the face status checker determines that there exists more than a predefined percentage of overlapping area between a face-like region and a tracked face, the face-like region is labeled as a tracked old face.

Claim 13 (Canceled)

14.(Currently Amended) The system for ~~tacking~~ tracking multiple faces rapidly as claimed in claim 10[[13]], wherein the filter finds a false face based on a combination of compactness of a tracked region, ratio between the height and width of a face, statistic variance of a face, number of holes existing ~~existed~~ in a region, and convexity of a face.

15.(Currently Amended) The system as claimed in claim 10[[13]], wherein, when a tracked face is a new face, the face tracking engine directly adds the new face to the face recorder; when a tracked face is an old face, the face tracking engine determines whether there exists more than a predefined percentage of overlapping area between the old face and a skin region; ~~and~~ if yes, it is determined that the old face is still occurring in the current frame and locating ~~its position~~ is in the center of the skin region; and if there does not exist more than a predefined percentage of overlapping area between the old face and a skin region, ~~otherwise,~~ the position of the old face is determined by correlation operation.

16.(Currently Amended) The system for ~~tacking~~ tracking multiple faces rapidly as claimed in claim 11, wherein the skin region extractor generates a plurality of connected skin regions based on an adaptive skin color model representing skin features of different ~~people~~ person.

17.(Currently Amended) A method for rapidly ~~tacking~~ tracking multiple faces comprising the steps of:

(A) detecting skin color pixels of an input image for generating a plurality of skin regions;

(B) determining possible face-like regions in the skin regions based on moving information of the input image;

(B') analyzing whether there exists a raised shape in the image to accordingly separate connected face regions, wherein it is determined that there exists a face-like region based on the following condition: e(i)>w and e(j)<-w, where w=0.5*(p(j)-p(i)); e(i)=d(p(i)); d(x)=v(x-1)-v(x+1); v(x) denotes a vertical position of the first touched pixel of a connected region when tracking all pixels of an image along the x-th column from top to down; e( ) denotes the edge response of a vertical edge; p( ) denotes a position of the vertical edge; i denotes an ith pixel; j denotes a jth frame; and w denotes a weight of the face-like region;

(C) checking the face-like regions and tracked faces previously stored to determine whether the face-like regions are old faces that have been tracked in a previous frame or [[are]] possible new faces that are newly occurring in a current frame, wherein, if the face-like regions are the old faces, it is further determined whether there exists more than a predefined percentage of overlapping area between an old face and a skin region;[[,]] ~~and~~ wherein if ~~yes~~ there exists more than a predefined percentage of overlapping area between the old face and a skin region, ~~it is determined~~ the face tracking engine determines that the old face is still in the current frame and locates ~~its position is~~ in the center of the skin region; and if there does not exist more than a predefined percentage of overlapping area between the old face and a skin region, ~~otherwise,~~ the position of the old face is determined by a correlation operation; and

(D) determining whether the possible new ~~face is a true~~ faces are new faces; ~~, and~~ if yes, recording the new ~~face~~ faces.

18.(Currently Amended) The method as claimed in claim 17 [[1]], wherein in step (C), if there exists more than a predefined percentage of overlapping area between the face-like region and a tracked face, the face-like region is an old face that has been previously tracked.

19.(Original) The method as claimed in claim 17, wherein in step (B), luminance difference between two successive images is used as a moving information, and a pixel is defined as a moving pixel if its luminance difference between two adjacent images is larger than a threshold; if there is more than a predefined percentage of pixels classified as moving pixels in a skin region, the region is labeled as a possible face-like region.

Claims 20 and 21 (Canceled)

22.(Currently Amended) The method as claimed in claim 17[[20]], wherein, in step (D), false faces from the input possible new faces are first filtered out, and the other possible new faces are verified for finding ~~true~~ new faces by eigen-face analysis.

23.(Currently Amended) The method as claimed in claim 20, wherein, in step (D), the false faces are found based on a combination of compactness of a tracked region, ratio between the height and width of a face, statistic variance of a face, number of holes existing ~~existed~~ in a region, and convexity of a face.